

大塚啓二郎編『技術移転と産業発展の長期的展開過程：インドとタイにおけるオートバイ産業と自動車産業の比較研究』調査研究報告書 アジア経済研究所  
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## 第1章

### **A Review of the Literature on Productivity Impacts of Global Value Chains and Foreign Direct Investment: Towards an Integrated Approach**

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and

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#### **Abstract**

Information spillovers from multinational enterprises to local firms in developing countries are examined in the literature on global value chains (GVCs) and foreign direct investment (FDI). However, both GVC and FDI studies are carried out independently and separately. On the one hand, GVC studies are insightful but largely descriptive and conceptual, without rigorous quantitative analysis. On the other hand, FDI studies are quantitative, focusing on the impacts of the productivity of local enterprises in developing countries; however, their frequently used estimation functions have several restrictive assumptions. The present review of previous GVC and FDI studies shows that these two strands of the literature are concerned with information spillovers, absorptive capacity of domestic enterprises, and backward linkages between foreign and domestic enterprises, even though their theoretical perspectives differ substantively. This literature review concludes that an integrated approach of incorporating the insightful perspective of GVC studies into the empirical specification of FDI studies will likely lead to more meaningful empirical findings that may reveal in greater depth the mechanisms underlying the productivity improvements of local enterprises in developing countries.

Keywords: foreign direct investment, global value chains, information spillovers, absorptive capacity, backward linkages, integrated approach

JEL codes: F21, F23, F63, O33

Information or knowledge spillovers from the internationally dispersed activities of multinational enterprises (MNEs) to domestic enterprises are an important source of technological progress in developing countries. For example, the World Bank (2012) considers foreign direct investment (FDI) as an important element for job creation in developing countries through information spillovers on productivity improvements. UNCTAD (2013) discusses the extent to which local enterprises in developing countries benefit from participating in global value chains (GVCs) in terms of increases in value-added, employment, income, and exports. Indeed, the majority of developing countries have attempted to attract FDI by establishing investment promotion agencies (Harding and Javorcik 2011); moreover, developing countries are beginning to attract and absorb more global FDI flows than developed countries.<sup>1</sup>

The main focus of both FDI and GVC studies is to examine the impact of MNEs dispersed activities on productivity improvement of local firms in developing countries. The main interest of FDI studies is to empirically elucidate the impacts of knowledge spillovers from FDI inflows on the productivity of domestic firms in the host countries and identify factors that affect the strength of such spillover effects, with many statistical analyses on this topic.<sup>2</sup> In contrast, GVC studies on the productivity impacts are largely conceptual and descriptive, mainly exploring why domestic firms have specific types of relationships with lead firms, termed “GVC governance” (Gereffi et al. 2005), and whether certain types of GVC governance are associated with particular types of upgrading (i.e., increase in value-added activities; Humphrey and Schmitz 2002; Giuliani et al. 2005).<sup>3</sup>

However, these studies are carried out independently or separately. For example, none of the representative empirical studies analyzing the impacts of FDI inflows on the productivity of domestic firms in developing countries, such as Aitken and Harrison (1999), Javorcik (2004), and Javorcik and Spatareanu (2008), refer to seminal GVC studies such as Humphrey and Schmitz (2002) and Gereffi et al. (2005). In contrast, GVC studies focus on the role of global buyers rather than MNEs, even though both global buyers and MNEs are potential sources of new useful knowledge. Only a few studies analyze the effects of FDI presence on the upgrading trajectories (Murakami and Hernández 2016) or the inter-firm relationships (Saliola and Zanfei 2009) in developing countries, while applying analytical concepts and tools of both FDI and GVC studies. Nonetheless, shifting production bases from developed to developing countries can be achieved by either relocating a production base from a parent company to its foreign affiliates (i.e., FDI), which, in turn, use local suppliers, or outsourcing the production of

goods and services to local suppliers or third-party providers by creating GVCs. Considering this, both GVC and FDI studies are bound to have common interests. Note that although after the path-breaking study of Antràs and Helpman (2004), a number of empirical studies analyze MNEs' organizational choice of GVCs (i.e., FDI versus foreign outsourcing), they do not analyze the productivity impacts of MNEs on local parts suppliers.<sup>4</sup> These studies, therefore, are outside the scope of the present literature review.

Based on a review of the literature on the productivity impact of GVCs and FDI, this study finds that these two strands of research are commonly interested in not only technological and managerial information spillovers but also in the absorptive capacity of domestic firms and the backward linkages between foreign and domestic firms. In addition, this study demonstrates the significant scope for empirical research to make new contributions to the literature on the impacts of FDI on industrial development in developing countries by incorporating the insightful perspective of the GVC approach into empirically rigorous FDI studies.

Specifically, GVC studies are interested in the mechanism that changes the status of local parts suppliers from “captive” to “relational” because such a change is associated with technology transfer from foreign firms to local suppliers. This change will be reflected in the growth of total factor productivity (TFP) of local firms, which is the focus of FDI studies. Therefore, an integration of the two strands of studies is expected to enrich empirical studies dealing with the productivity impacts of FDI.

The rest of this paper is organized as follows. The second section discusses the major contributions and limitations of GVC studies from the comparative viewpoint of FDI studies. The third section reviews the major findings of existing studies of the channels of knowledge spillovers from FDI and their impacts on productivity as well as the determinants of FDI spillovers in developing countries. The fourth section makes further suggestions for enriching FDI studies by incorporating the insightful perspective of GVC studies. The final section concludes and suggests new areas of research useful for facilitating industrial development policies in developing countries.

## **Research on GVCs**

### ***Topics of GVC studies***

Global value chains are defined as “fragmented supply chains, with internationally dispersed tasks and activities coordinated by a lead firm” (UNCTAD 2013, 125). Typically, GVC studies aim to explore 1) the types of local firms' relationships with lead firms (i.e., GVC governance), and 2) the relationships between GVC governance and the type of upgrading. Specifically, upgrading is defined as “making better products, making

them more efficiently, or moving into more skilled activities” (Giuliani et al. 2005, 552).

Gereffi et al. (2005) argue that GVC governance is determined by three factors: complexity of transactions, ability to codify transactions, and supply base capabilities. We assume that the complexity of transactions is closely associated with transaction costs, the ability to codify transactions refers primarily to the ability to codify production systems, and supply base capabilities encompass those of production and management. Thus, if transaction costs are high, codification of the production system is difficult, and local producers are incapable, the lead firm internalizes its production activities by setting up its own affiliates (i.e., FDI). Gereffi et al. (2005) label this governance type “hierarchy.” However, they do not discuss transactions between foreign affiliates and local firms, which is one of key issues in FDI studies. If transaction costs are high and codification of the production system is difficult, but local producers are capable of production and management activities, the lead firm outsources its activities to local producers, with the aim to seek mutually dependent and beneficial relationships. The development of a good reputation, higher trust created by repeated transactions, and family and ethnic ties between the lead firm and local producers enable such relationships to flourish. Gereffi et al. (2005) label this governance type “relational.” Conversely, if transaction costs are high and local producers are incapable, but codification of the production system is easy, the lead firm outsources its activities to local producers and tightly monitors and controls them. In this case, local firms passively receive materials and production instructions from the lead firm. Gereffi et al. (2005) label this governance type “captive.” As Figure 1 demonstrates, information flow is bidirectional in a relational value chain, while unidirectional in a captive value chain.

In addition to the typology of the relationships between the lead firm and local firms, GVC studies discuss the relationships between the different types of GVC governance (e.g., captive or relational) and different types of upgrading. GVC studies usually define functional upgrading as a shift to higher value-added activities within a given value chain such as design, marketing and branding, while defining product upgrading as a shift to more sophisticated product lines with higher unit values, and process upgrading as a more efficient transformation of inputs into outputs by reorganizing the production system or introducing superior technology within a given type of output (Humphrey and Schmitz 2002; Giuliani et al. 2005).<sup>5</sup>

Integration into value chains in which local firms have symmetric relationships with the lead firm (e.g., relational value chains) offers favorable opportunities for functional upgrading because local producers that are capable of management activities and have relatively strong bargaining powers vis-à-vis the lead firm can negotiate their

assigned tasks in the value chains (Humphrey and Schmitz 2002, 2004; Giuliani et al. 2005; Morrison 2008; Pietrobelli and Rabellotti 2011). In fact, Bair and Gereffi (2001) find that some capable first-tier suppliers in the apparel industries in Mexico have succeeded in extending their tasks towards pre- and post-assembly stages, thus becoming full-package suppliers. Dolan and Humphrey (2004) find that selected relational suppliers in the fresh vegetable industries in Kenya and Zimbabwe engage in some management activities relinquished by their lead firms. Ponte et al. (2014) also find that relational suppliers in the aquaculture industries in Thailand have achieved functional upgrading by participating in higher value-added activities such as R&D, product development, and marketing research.

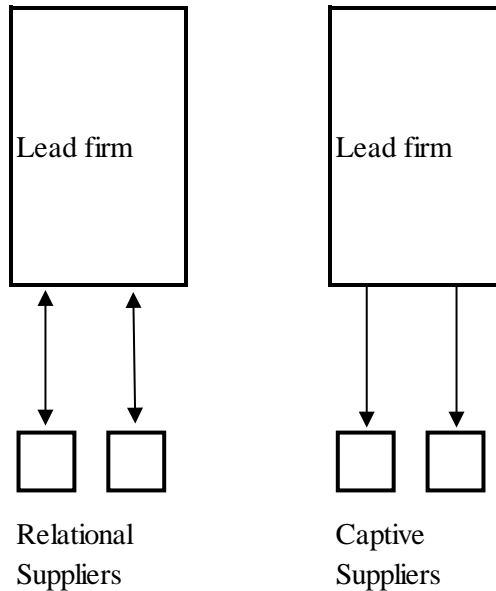
In contrast, integration into value chains in which local firms are under captive relationships with lead firms offers unfavorable conditions for such functional upgrading (Humphrey and Schmitz 2002, 2004; Giuliani et al. 2005; Schmitz 2006; Pietrobelli and Rabellotti 2011). This case confines local producers to simple tasks and discourages them from engaging in value-added activities such as production design and marketing because of their low-level management abilities. In fact, many case studies find limited possibilities of functional upgrading of captive suppliers in developing countries, including Dolan and Humphrey (2000, 2004) for the fresh vegetable industries in Kenya and Zimbabwe; Schmitz and Knorrninga (2000) for the footwear industry in Brazil, China, and India; Bair and Gereffi (2001) for the apparel industry in Mexico; Bazan and Navas-Alemán (2004) for the footwear industry in Brazil; Avdasheva (2007) for the furniture industry in Russia; Navas-Alemán (2011) for the footwear and furniture industries in Brazil; and Sato (2011)<sup>6</sup> for the motorcycle industry in Indonesia.

Both relational and captive suppliers are interested in upgrading the quality of their products and production processes by learning from their production experience (Humphrey and Schmitz 2002; Pietrobelli and Rabellotti 2011). However, captive suppliers have particularly favorable opportunities for process and product upgrading, because the risk of supplier failure leads foreign firms to assist local firms in upgrading production capabilities (Humphrey and Schmitz 2002, 2004; Giuliani et al. 2005; Schmitz 2006; Altenburg et al. 2008; Pietrobelli and Rabellotti 2011). In fact, some case studies such as Bazan and Navas-Alemán (2004) Navas-Alemán (2011), and Ponte et al. (2014) find that captive suppliers are likely to achieve process and product upgrading.

In sum, relational suppliers are more successful at functional upgrading than captive suppliers because of the open-ended opportunities available for all types of upgrading and their superior entrepreneurial abilities. Indeed, relational suppliers are rarely found in developing countries (Humphrey and Schmitz 2004; Giuliani et al. 2005;

Morrison et al. 2008).

Figure 1. Two types of GVC governance: captive and relational value chains



Source: Authors' own elaboration, based on Figure 1 of Gereffi et al. (2005, 89).

Note: Arrows show the directions of order and information.

### ***Contributions of GVC studies***

Based on the conceptual framework of GVC studies such as Humphrey and Schmitz (2002) , Gereffi et al. (2005), and Schmitz (2006), Sato and Fujita (2009) explicitly consider functional upgrading to be the action of widening capabilities from production to pre- and post-production management. For example, relational suppliers may actively participate in such pre-production activities as marketing research, technology choice and development, and production design as well as such post-production activities as branding and marketing. Sato and Fujita's (2009) concept about functional upgrading is similar to Gereffi's (1999) concept about industrial upgrading, which is the shift of local producers' tasks and functions from mere assembly of imported inputs to full-package supply or original equipment manufacturing (OEM) production, to own design manufacturing (ODM) production, and eventually to original brand name manufacturing (OBM) production.

However, lead firms usually discourage local firms from participating in value-added pre- and post-production activities because they consider such activities as their core competencies and the major source of their profit (Schmitz and Knorringa 2000; Bair

and Gereffi 2001; Humphrey and Schmitz 2002; Bazan and Navas-Aleman 2004; Schmitz 2006; Altenburg et al. 2008; Morrison et al. 2008; Schmitz and Strambach 2009). Indeed, many case studies find that local suppliers in developing countries often achieve process and product upgrading but not functional upgrading (Schmitz and Knorrinda 2000; Bazan and Navas-Aleman 2004; Navas-Alemán 2011; Sato 2011; Ponte et al. 2014). Yet, a recent survey of the GVC literature by Choksy et al. (2017) concludes that functional upgrading is a key determinant of increased profit margins for suppliers in developing countries.

In addition, the concept of the “smile curve” in GVCs has been widely debated and highlights that tasks in pre- and post-production activities tend to generate higher value-added than those in production activities per se, such as manufacturing and assembling (Mudambi 2008; Shin et al. 2012). Thus, the insight of Sato and Fujita (2009) provides an important mechanism underlying the productivity improvements of local firms: once local firms obtain higher capabilities as suppliers to MNEs, they participate in relational value chains, instead of captive value chains. This evolution of local firms’ relationships with MNEs extends their functions toward high value-generating tasks related to pre- and post-production activities. In fact, Poon (2004) finds such evolutionary processes in local suppliers in Taiwan’s IT industry: local suppliers that originally engaged in simple assembly tasks gradually upgraded their technological and management capabilities through technology transfer from MNEs and later became involved in higher value-generating tasks such as product design and OBM.

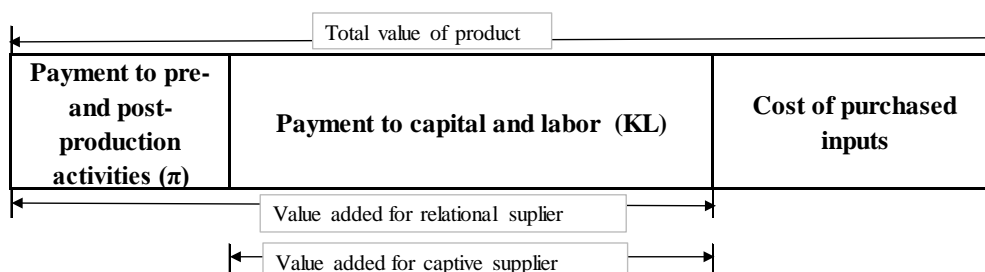
The distinction between captive and relational contracts is similar to the distinction between contracts with “drawings supplied” and “drawings approved” in the automobile industry in Japan (Asanuma 1989). In the former case, suppliers manufacture parts according to the drawings or blueprints that core firms supply; in the latter case, suppliers manufacture parts according to the drawings that suppliers provide and the core firm approves. According to Asanuma (1989), “drawings approved” have become more common over time, replacing “drawings supplied.” We consider that this process corresponds to the evolution from captive to relational contracts, which is consistent with the observation of the Japanese automotive industry by Sturgeon et al. (2008). How local producers transform themselves from captive to relational suppliers is a major development issue.

This argument is consistent with the recent findings in the field of development economics that emphasize the role of management practices and managerial human capital in improving the performances of manufacturing firms in developing countries (Bruhn et al. 2010; Bloom et al. 2013; Sonobe and Otsuka 2014; Bloom et al. 2016). In a study of the productivity improvements of acquired plants in Indonesia from 1983 to 2001,

Arnold and Javorcik (2009) suggest that foreign firms employ organizational and managerial systems that make the production process more efficient.

To illustrate the distinction between captive and relational contracts, Figure 2 shows how total value-added is distributed to the local parts supplier and the MNE. We assume that total value-added consists of payments to labor and capital (designated by areas KL) and profit ( $\pi$ ) accrued to management activities, including technology choice, production design, and marketing. In this framework, when management improves without changing the employment of capital and labor,  $\pi$  as well as total value-added will increase, which will be reflected in increases in TFP.

Figure 2 Components of the value added in captive and relational suppliers



Source: Authors' own elaboration.

Under a captive governance system, a local firm receives only area KL, whereas an MNE receives the whole of  $\pi$ . This is reasonable, because captive suppliers are assigned simple tasks in production activities, and the MNE discourages them from engaging in value-added activities such as production design and marketing. In contrast, if the local firm is highly capable of management activities and independent, the local supplier that engages in pre- and post-production management activities receives the major part or even the whole area of  $\pi$ . This is consistent with the view of Dedrick et al. (2010), who point out that functional upgrading of parts suppliers increases the share accrued to these suppliers. We believe that such a shift from being a captive supplier to a relational supplier is crucial to the industrial development process. However, the production function approach, which FDI studies use exclusively, merely captures this shift as technological improvement.

Further, it is necessary to also point out that GVC studies made useful observations about FDI, which are not mentioned in FDI studies. First, Hobday and Rush (2007) observe that foreign subsidiaries also improve productivities over time through learning and adaptation, even though FDI studies do not pay any attention. Thus, the

productivity of foreign firms is not wholly exogenous. Second, Sturgeon et al. (2008) point out that in automobile industries, first-tier suppliers in advanced countries initiate production in developing countries after automobile companies relocate their production bases. This indicates that vertical linkages between foreign firms and their first-tier suppliers are not created in developing countries but transferred from advanced to developing countries to some extent. Third, Bair and Gereffi (2001), Dolan and Humphrey (2004), and Fujita (2011) find that small-sized lower-tier suppliers are especially inactive in functional upgrading because first-tier local suppliers as well as foreign firms exert tight control on their incapable subcontractors, especially confining them to simple assembly tasks. However, FDI studies do not consider the possibility that productivity impacts of foreign firms may differ among suppliers' position in a given value chain.

### ***Shortcomings of GVC research***

Although the mechanism underlying the productivity improvements of local firms that GVC studies suggest closely relates to the inter-industry spillover effects of FDI through the supply of parts and components to MNEs (backward linkages), detailed analysis on such dynamic mechanism is not the main concern of seminal GVC studies such as Humphrey and Schmitz (2002) and Gereffi et al. (2005).

It is worth noting that recent GVC studies such as Morrison et al. (2008), Sato and Fujita (2009), Kawakami and Sturgeon (2011), Lema (2012), and Lema et al. (2015) have pointed out that local suppliers' capabilities are not exogenous. Thus, the above-mentioned seminal GVC studies do not provide the analytical framework to explain how local suppliers can develop their capabilities. New GVC studies have developed their own analytical frameworks to analyze the endogenous process and mechanism of local suppliers' capability development and innovation such as "capability matrix" (Sato and Fujita 2009) and "organizational decomposition of the innovation process" (Schmitz and Strambach 2009; Lema et al. 2015).

Another important reason for the neglect of the evolutionary processes of local industries stems from the location and functions of foreign and local firms that GVC studies consider. GVC studies, especially those analyzing "buyer-driven" chains, such as Schmitz and Knorringer (2000), Dolan and Humphrey (2000, 2004), Bair and Gereffi (2001), Avdasheva (2007) and Navas-Alemán (2011), consider foreign firms to be global buyers (e.g., branded marketers, retailers, and branded manufactures) located in developed countries, while they consider local suppliers to be exporters located in developing countries (Gereffi, 1999).<sup>7</sup> Thus, such GVC studies assume that the main role

of foreign firms is to control or coordinate the GVC as well as to engage in non-production activities such as design, marketing, and branding, without directly engaging in production activities or procuring any inputs from local firms in developing countries.

Finally, the quantitative foundations for the arguments of GVC studies are weak, although they engage in many case studies. The findings of GVC studies show that the changes in local suppliers' relational status vis-à-vis foreign firms are crucial for their productivity improvements, which is a major issue for FDI studies. Subsequently, a few researchers carried out empirical studies on the productivity of local firms and the types of GVC governance; however, these studies lacked a rigorous econometric methodology. For example, Pietrobelli and Saliola (2008) empirically analyze the impacts of different types of GVC governance on the productivity of local firms in Thailand from 2001 to 2003. Saliola and Zanfei (2009) empirically analyze the impacts of the technological capabilities of local firms as well as the presence and characteristics of foreign firms on the different types of GVC governance in Thailand, using the same cross-sectional data used by Pietrobelli and Saliola (2008). However, to what extent their categorization is based on the original concept of Gereffi et al. (2005) is uncertain. Although the types of GVC governance and technological capabilities of local firms are endogenous, the authors do not deal with the endogeneity issue.

## **Research on FDI**

### ***Channels of knowledge spillovers from FDI***

Although numerous studies discuss the channels of knowledge or information spillovers from FDI, there is inconsistency and confusion about their conceptual classification. In general, there are four major spillover effects: demonstration, labor turnover, competition (i.e., the effect of entry of MNEs on market demand for products produced by competing local firms), and vertical linkage (i.e., the externalities derived from the backward linkages between MNEs and domestic firms). However, review articles such as Saggi (2002), Crespo and Fontoura (2007), and Smeets (2008) assume that the demonstration and imitation effects are identical. We argue that we should separate, at least conceptually, free copying, which corresponds to the demonstration effect, from resource-using activities, which corresponds to the imitation effect. This is because we should analytically separate the case of freely appropriable knowledge or technologies of foreign firms from the case in which only domestic firms that expend conscious effort can acquire useful new knowledge. The absorptive capacity of domestic firms is particularly relevant in the latter case. Further, although studies such as Saggi (2002), Görg and Strobl (2005), Crespo and Fontoura (2007), Smeets (2008), and Javorcik (2014) consider the labor

turnover effect in addition to the demonstration effect including imitation effect, we argue that labor turnover from foreign to domestic firms is one way of imitation, as it must incur the cost of recruiting and employing new workers.

The major problem with the classifications of existing studies, except for Javorcik (2014), is that they do not differentiate between pure and pecuniary externality effects. Since competition and vertical linkage effects undoubtedly occur through market mechanisms (market competition and purchases as well as sales of inputs), we argue that we should treat these effects separately from pure externality effects. The vertical linkage effects could also occur through training for workers in local firms by foreign affiliates. Additionally, the vertical linkage effect could accompany pure externality effects if parts suppliers learn from foreign firms through demonstration and imitation.<sup>8</sup> Therefore, we argue that demonstration, imitation, and some sort of vertical linkage are the pure externality effects of FDI, which should be separated from the pecuniary externality effects (i.e., competition effects and some sort of vertical linkage effect such as training) arising from market mechanisms (see Table 1).

In the next step, we can classify these four channels of knowledge spillovers from FDI into either inter-industry or intra-industry effects. The competition effect is an intra-industry spillover effect, while the vertical linkage effect is an inter-industry effect. Moreover, since the demonstration and imitation effects could occur between firms in the same industry as well as between vertically related firms (e.g., with regard to management methods), they can be both inter-industry and intra-industry effects.

The literature deems that the effects of demonstration, imitation, and backward linkage to improve the productivity of domestic firms (Crespo and Fontoura 2007). However, the competition effect can have both positive and negative impacts on productivity (see Table 1). On the one hand, if intensified competition with MNEs were to induce domestic firms to use existing resources and technologies more efficiently, it would improve their productivity (Görg and Greenaway 2004; Crespo and Fontoura 2007). On the other hand, if this intensified competition were to cause domestic firms to lose their market share, with a consequent increase in their average costs, it would decrease their productivity (Crespo and Fontoura 2007; Javorcik 2014).

Table 1. Impacts of the four channels of knowledge spillovers from FDI on local firms' productivity

	Pure externality	Pecuniary externality
Demonstration	+	
Imitation (Labor turnover)	+	
Competition		− or +
Vertical linkage	+	+

Source: Authors' own elaboration.

Notes: + and − indicate that the channel theoretically has positive and negative impacts, respectively, on domestic firms' productivity.

### ***Empirical assessment of knowledge spillovers from FDI***

As Smeets (2008) summarizes, the literature commonly analyzes information spillover effects from FDI by estimating the following function:

(1)

$$\ln Y_{ijt} = \beta_0 + \beta_K \ln K_{ijt} + \beta_L \ln L_{ijt} + \beta_1 \text{Horizontal}_{jt} + \beta_2 \text{Backward}_{jt} + \beta_3 \text{Forward}_{jt} + \mathbf{X}'_{ijt} \boldsymbol{\beta}_4 + \mathbf{Z}'_{jt} \boldsymbol{\beta}_5 + \alpha_i + \alpha_j + \alpha_t + \varepsilon_{ijt}$$

where  $i$  indexes the firm;  $j$  and  $k$  index the industry;  $t$  indexes time;  $Y$  is the value-added of a domestic firm;  $K$  is capital;  $L$  is labor;  $\beta_k$  and  $\beta_l$  are the production elasticities of capital and labor, respectively; *Horizontal* is a measure of the presence of FDI in industry  $j$ , which is usually measured by the foreign firms' share of total employment or output (a "foreign" firm is commonly defined by the share of the equity owned by foreign investors in the given firm);<sup>9</sup> *Backward* is a measure of the presence of FDI in downstream industries to which industry  $j$  supplies inputs; *Forward* is a measure of the presence of FDI in upstream industries from which industry  $j$  purchases inputs;  $X$  is a vector of the firm-level control variables that are assumed to affect productivity such as the ratio of R&D expenditure and the level of workers' human capital;  $Z$  is a vector of the industry-level control variables such as the degree of market concentration and export orientation;  $\alpha_i$  is a time-invariant firm fixed effect;  $\alpha_j$  is a time-invariant industry fixed effect;  $\alpha_t$  is a time effect;<sup>10</sup> and  $\varepsilon$  is an error term.

We usually measure *Backward* and *Forward* by using the following formulae, respectively:

(2)

$$Backward_{jt} = \sum_{k \neq j} (a_{jkt} \cdot Horizontal_{kt}),$$

(3)

$$Forward_{jt} = \sum_{m \neq j} (\sigma_{jmt} \cdot Horizontal_{mt})$$

where  $a$  is the proportion of the output of sector  $j$  supplied to industry  $k$ . In other words, *Backward* is greater if the FDI in industry  $k$  purchases a larger amount of intermediate products from industry  $j$ .  $\sigma$  is the proportion of the input of sector  $m$  purchased by industry  $j$ .<sup>11</sup> In other words, *Forward* is greater if the FDI in industry  $m$  supplies a larger amount of intermediate products to industry  $j$ . Note that *Backward* or *Forward* is specific to the industry in this specification, implying that this variable captures the effect of inter-industry variations in backward or forward linkages, but not the effect of firm-specific backward or forward linkages. In equation (1), we assume that  $\beta_1$  captures the intra-industry (horizontal) effect, while  $\beta_2$  and  $\beta_3$  capture the inter-industry (vertical) effect.

The representative FDI studies such as Aitken and Harrison (1999), Castellani and Zanfei (2003), Javorcik (2004), Bwalya (2006), Haskel et al. (2007), Blalock and Gertler (2008), and Barrios et al. (2011) estimate equation (1) or its first-differences by using firm-level panel data in a variety of industries.<sup>12</sup> Rather than or in addition to estimating equation (1) directly, Liu (2008), Javorcik and Spatareanu (2008), Blalock and Gertler (2009), Keller and Yeaple (2009), Barrios et al. (2011), Javorcik and Spatareanu (2011), Fatima (2016), and Lu et al. (2017) estimate TFP first,<sup>13</sup> and then regress it on FDI spillovers and other control variables in equation (1), using either level or first-difference.

However, this frequently used estimation implicitly adopts the following restrictive assumptions. First, this specification assumes that knowledge spillovers, which are flows, affect the level of productivity, which is determined by the accumulated stock of useful knowledge.<sup>14</sup> Note, however, that Haddad and Harrison (1993), Sjöholm (1999), Chung et al. (2003), Girma (2005), Todo and Miyamoto (2006), and Ben Hamida and Gugler (2009) use estimation equations where the dependent variable is change so that knowledge spillovers affect productivity *changes* rather than *levels*.

Second, the spillover effect captured by  $\beta_1$  is only a demonstration effect because this term captures the effects that arise without any conscious effort by local firms

to learn, implying that it does not capture the spillover effects derived from imitation. Third, the measurement of backward and forward linkages shown in equations (2) and (3) employs highly restrictive assumptions; for example, foreign affiliates, regardless of their nationality, have the same input-sourcing behavior as domestic firms, as Barrios et al. (2011) point out.<sup>15</sup> Fourth, the spillover effects of FDI are identical across all industries, namely,  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  are identical, which enables the use of firm-level data in different industries to identify the spillover effects. Fifth, different industries have the same production function parameters, namely,  $\beta_k$  and  $\beta_l$  are identical. However, some studies using the two-stage estimation method, such as Haddad and Harrison (1993), Todo and Miyamoto (2006), Javorcik and Spatareanu (2008), Blalock and Gertler (2009), Javorcik and Spatareanu (2011), Fatima (2016) and Lu et al. (2017) separately estimate the production function in each industry in the first stage. Although Blalock and Gertler (2008) and Kee (2015) estimate equation (1) directly or estimate it in two stages, they include one industry or few homogeneous industries with similar technologies.

Thus, we argue that these studies, which have those restrictive assumptions especially do not avoid the second issue (neglect of imitation effects) or the fourth issue (identical spillover effects across industries), although they can avoid the first issue (the assumed effects of FDI's presence on the level of productivity) and the fifth issue (identical production function parameters across industries), and can avoid at least partially the third issue (identical input-sourcing behaviors of foreign firms regardless of their nationality), by using the above-mentioned modified forms. In sum, these restrictive assumptions are likely to lead to biased or imprecise estimations of the regression parameters.

In this regard, a specification of the estimation equation proposed by Griffith et al. (2004) is highly relevant. The authors analyze the determinants of the industry-level productivity growth of 12 OECD countries from 1974 to 1994. Although their original unit of analysis is country and industry, it is possible to change the unit of analysis from country to industry and from industry to firm in our discussion. Their specification has several advantages (see Appendix for revised estimation function). First, Griffith et al. (2004) assume that knowledge spillovers affect *changes* in productivity, but not the productivity *level*. Second, their specification predicts that the share of R&D expenditure in the firm, technological distance of this firm from the frontier firm in the same industry, and the interaction term between the firm's share of R&D expenditure and the technological distance affect productivity growth.<sup>16</sup> They also measure the technological

distance by using the difference in TFP. In other words, this specification separates the spillover effect automatically derived from the technological distance from the spillover effect derived from the resource-using activities, measured by R&D expenditure. Thus, this specification separates the demonstration effect from the imitation effect. Third, the use of each firm's technological distance from the frontier firm within the same industry allows each industry to have different horizontal spillover effects. Fourth, the authors use the superlative index number approach of Caves et al. (1982), which allows us to estimate TFP by using flexible production function parameters.<sup>17</sup>

Although the specification proposed by Griffith et al. (2004) is relevant for FDI research, some revisions are necessary. First, the interests of this study lie in the technological distance from the frontier firm, rather than foreign firms. Second, they focus on the spillover channels between firms in the same industry without considering any spillovers between firms in different industries (i.e., the backward and forward linkage effects). To address such problems, we must revise and extend the specification of this equation.

### ***Horizontal (intra-industry) spillovers***

Early studies using firm level cross-sectional data, such as Kokko (1994) and Chuang and Lin (1999), find positive intra-industry spillover effects. However, once industry- or firm-specific fixed effects are controlled by using panel data, the observed positive effects disappear, as Aitken and Harrison (1999), Javorcik (2004), and Liu (2008) find. These findings indicate that the positive impacts observed in the early cross-sectional studies may be generated by the larger presence of foreign firms in more productive industries rather than the outcome of productivity improvements by foreign firms (Smeets 2008; Javorcik 2014). Indeed, a few studies implementing firm-level panel data analysis find robust positive intra-industry effects; for example, for MNEs in the United Kingdom (UK) (Haskel et al. 2007) and in the United States (US) (Keller and Yeaple 2009), and for R&D-performing MNEs in Indonesia (Todo and Miyamoto 2006).

In contrast, many studies that estimate equation (1) or its modified forms by using firm-level panel data in developing countries find negative intra-industry spillover effects. The major examples are Aitken and Harrison (1999) for Venezuela from 1976 to 1989, Bwalya (2006) for Zambia from 1993 to 1995, Javorcik and Spatareanu (2008) for Romania from 1998 to 2003, Kee (2015) for Bangladesh from 1999 to 2003, Fatima (2016) for Turkey from 2003 to 2010, and Lu et al. (2017) for China from 1998 to 2007.

Furthermore, Javorcik and Spatareanu (2008) find that the negative impacts are smaller in partially owned foreign affiliates (joint ventures) than in wholly owned foreign

affiliates, because the former are more likely to use less sophisticated technologies transferred from headquarters than the latter; thus, domestic firms can absorb such technologies more easily from partially owned foreign affiliates through the demonstration or imitation effects. Interestingly, Liu (2008) finds negative impacts in the short term but positive impacts in the longer term, thereby indicating that the spillover effect is likely to arise from imitation, requiring resource-using and time-consuming R&D activity. In addition, some studies such as Haddad and Harrison (1993) find no significant intra-industry spillover effects for the case of Morocco from 1985 to 1989.

Therefore, the major findings in the literature indicate that the negative impacts of the competition effect dominate the positive knowledge spillover effects (demonstration and imitation) in the short term in most developing countries (Javorcik and Spatareanu 2008; Javorcik 2014). Thus, the presence of foreign firms in most developing countries does not unconditionally generate positive horizontal externality effects. In other words, what matters could be the imitation effect but not the demonstration effect, implying that the absorptive capacity of domestic firms is likely to play a role.

Since these studies reviewed in this subsection typically apply equation (1) or its modified forms, the estimation results are likely to suffer from the misspecification of the functional relationships. Especially, since these studies assume identical horizontal spillover effects across all industries, they could estimate some kind of average effects across them. Thus, it is likely that some industries have positive horizontal effects, while many others have negative horizontal effects.

### ***Vertical (inter-industry) spillovers***

Before Javorcik's (2004) path-breaking study, the majority of empirical studies on FDI analyzed intra-industry effects.<sup>18</sup> Since the publication of Javorcik (2004), many studies have found positive backward linkage effects based on equation (1) and its modified forms by using firm-level panel data, including Bwalya (2006) for Zambia from 1993 to 1995, Blalock and Gertler (2008) for Indonesia from 1988 to 1996, Javorcik and Spatareanu (2008) for Romania from 1998 to 2003, Javorcik and Spatareanu (2011) for Romania from 1998 to 2003, Barrios et al. (2011) for Ireland from 1983 to 1998, Kee (2015) for Bangladesh from 1999 to 2003, Fatima (2016) for Turkey from 2003 to 2010, and Lu et al. (2017) for China from 1998 to 2007.<sup>19</sup> In her survey article, Javorcik (2014) also concludes that inter-industry effects are clearer than intra-industry effects.

Although some studies such as Javorcik (2004), Liu (2008), and Barrios et al. (2011) include the term capturing the effects of forward linkages in addition to backward

linkages as shown in equation (1), they find that there is no robust evidence of spillovers occurring through forward linkages. This finding is attributable to the fact that local firms are typically engaged in upstream activities such as parts-supplying, whereas MNEs are mostly engaged in downstream activities. Only a few recent studies such as Fatima (2016) and Lu et al. (2017) find positive forward linkage effects. Based on the meta-analysis, Havranek and Irsova (2011, 237) conclude that “the literature suggests that backward spillovers are economically important, forward spillovers are statistically significant but small, and horizontal spillovers are insignificant.”

The finding that the backward linkage effect is the major channel for the positive spillovers indicates that subcontracting relationships between local firms in upstream industries and MNEs in downstream industries are crucial for improving the productivity of local firms. Thus, the findings of FDI studies strongly relate to the argument of GVC research concerned with the inter-firm governance issues, as discussed in the second section.

#### ***Labor turnover, absorptive capacity, and agglomeration economies***

Some studies pay special attention to the role of labor turnover, absorptive capacity, and agglomeration economies in disseminating FDI’s useful knowledge to local firms. Both GVC and FDI studies are commonly interested in these issues.

Typically, the literature estimates the impacts of labor turnover by including the share of owners and workers who have previous work experience in or training experience by MNEs in the same industry in equation (1), instead of the horizontal linkages measured by the share of FDI.<sup>20</sup> For example, analyzing manufacturing firms in Ghana from 1991 to 1997, Görg and Strobl (2005) find that owners’ previous work experience in MNEs in the same industry has positive impacts on domestic firms’ productivity. In addition, Balsvik (2011) finds that the share of workers with experience in MNEs has positive impacts on the productivity of domestic plants in Norway from 1990 to 2000. Fosfuri et al. (2001) provide some theoretical foundations for the impacts of labor turnover by showing that FDI technological spillovers caused by workers’ mobility occur if MNEs do not compete fiercely with domestic firms in the same product market, and the absorptive capability of the local firm is sufficiently high.

Other studies focus on the impacts of labor turnover on individual workers’ wages in domestic firms, instead of their productivity, although the estimation strategy is similar to these studies estimating the impacts on productivity.<sup>21</sup> For example, Poole (2013) finds that the share of former MNE workers has positive impacts on the wages of remaining workers in domestic firms in Brazil from 1996 to 2001, after controlling for

various individual as well as firm-level characteristics. This finding could indicate that former MNE workers bring new useful knowledge for workers in local firms.<sup>22</sup>

However, some time-variant positive shocks in such domestic firms may correlate with both the new hiring of former MNE workers and the increase in productivity or wages in these three studies (i.e., Görg and Strobl 2005; Balsvik 2011; Poole 2013). Thus, we require empirical analyses using more explicit indicators of imitation through labor turnover. However, official data on such indicators are limited and original firm-level surveys may have to be carried out.

Typically, the literature estimates the impacts of absorptive capacity by including an additional interaction term between the measures of the presence of FDI and of absorptive capacity in equation (1).<sup>23</sup> In other words, such equations estimate whether the impacts of FDI presence in the given industry differ according to the firm's absorptive capacity. The literature often measures the absorptive capacity of domestic firms based on their R&D expenditure (Cohen and Levinthal 1989; Griffith et al. 2004). Moreover, studies measure the technology gap by the ratio of the highest (frontier-level) productivity within the same industry to that in domestic firms (Griffith et al. 2004) or by the ratio of productivity in foreign firms to that in domestic firms (Castellani and Zanfei 2003; Jordaan 2008).

There are two contrasting views regarding the impacts of the technology gap on domestic firms' productivity (Castellani and Zanfei 2003; Smeets 2008; Imbriani et al. 2014). On the one hand, the "catching up" hypothesis argues that large technology gaps between domestic firms and MNEs can enhance the spillovers effects of FDI because of the greater potential for technological improvements (Findlay 1978; Wang and Blomstrom 1992). In this case, the coefficient of the interaction term of FDI presence with the technology gap measure should be positive. On the other hand, the higher absorptive capacity of local firms can enhance the positive spillover effects of FDI, making the coefficient of the interaction term between the presence of FDI and absorptive capacity positive.

We summarize previous empirical findings as follows. Castellani and Zanfei (2003), analyzing firm-level panel data in France, Italy, and Spain from 1992 to 1997, find that the interaction term of FDI presence with the technology gap measure has a significantly positive coefficient, while the interaction term with the absorptive capacity measure has no significant coefficient. Jordaan (2008), analyzing spillover effects of FDI in several Mexican regions in 1993, also finds that the interaction term of FDI presence with the technology gap measure has a significantly positive coefficient. Thus, these findings support the catching-up hypothesis. In contrast, Fatima (2016) finds that the

interaction term of FDI presence with the technology gap measure has a significantly negative coefficient in Turkish firms in both manufacturing and service sectors from 2003 to 2010. Blalock and Gertler (2009) find that the interaction term of FDI presence with the absorptive capacity measure (i.e., R&D expenditure) has a significantly positive coefficient in Indonesian manufacturing firms from 1988 to 1996.

Some researchers consider the relationship between the technology gap and degree of productivity benefits from FDI to have an inverted U-shape: the productivity benefits are likely to be small for both low- and high-technology gaps, while they are high for intermediate technology gaps. Indeed, Girma (2005) finds the existence of an inverted U-shaped relationship between the technological gaps and productivity benefits from FDI in manufacturing firms in the UK from 1989 to 1999. In addition, Ben Hamida and Gugler (2009), analyzing firm-level panel data from both manufacturing and services/construction sectors in Switzerland from 1998 to 2001, find that intra-industry FDI presence has positive impacts on local firms' productivity only when local firms have intermediate technology gaps with foreign firms. In contrast, there are no significant impacts when local firms have small and large technology gaps.

Several studies find other mechanisms that attenuate the negative horizontal linkage effects of FDI. For example, Girma et al. (2015), using firm-level data from manufacturing industries in China from 2004 to 2006, find that the presence of foreign firms has positive impacts on domestic firms' productivity only when the foreign presence reaches a certain threshold (i.e., 40%) within a cluster. Furthermore, Lu et al. (2017) find that intra-industry FDI in the same city has positive impacts on domestic firms' productivity, while that in more distance areas has negative impacts. Such positive effects may arise from agglomeration economies, which facilitate information spillovers, mobility of workers from foreign to domestic firms, and inter-firm transactions. This is likely to be important, as most manufacturing industries are clustered in developing countries (Sonobe and Otsuka 2006, 2011, 2014).

### **Towards an integration of FDI and GVC studies**

In this section, we suggest ways in which to incorporate the perspectives of GVC studies into the framework of FDI studies. From the perspective of development of local firms and industries, analyzing how and under what conditions captive suppliers transform into relational suppliers is crucial. The important question that needs to be addressed is to identify the determinants of governance types or determinants of the shift from captive to relational suppliers. Estimating a multinomial logit function to identify the determinants of the governance types, Saliola and Zanfei (2009) find that technological competence of

local firms relates positively with the choice of knowledge-intensive value chains. A recent survey of the descriptive GVC studies by Choksy et al. (2017) also suggests that functional upgrading is more likely to occur in the case of privileged suppliers, which are larger, possess more resources, and have a stronger industrial position than non-privileged suppliers.

Since the governance types of the contract between foreign and local firms affect the division of value-added between foreign and local firms, as discussed in Figure 2, measured TFP is supposedly affected by the governance types. Thus, we propose to include the governance type as an explanatory variable in the revised TFP change function. Challenges of this new estimation are how to identify the governance types and how to deal with the endogeneity of such variables.

While we cannot determine the best proxy variable for the relational contract a priori, we can suggest several possibilities. The first group of variables refer to the suppliers' position in a given value chain. First-tier suppliers are likely to have relational contracts with foreign firms, as suggested by Bair and Gereffi (2001) and Dolan and Humphrey (2004). The second group pertains to the independence of the decision-making authority of the supplier, such as the number of contracting foreign firms and the sales share of the dominant contracting foreign firm. This is because the diversification of customers and markets suggests the symmetric and independent relationships local suppliers have with foreign firms and, thus, their shift to relational suppliers (Dolan and Humphrey 2004; Fujita 2011). Schmitz (2006) also concludes that diversification of markets and customers facilitates the functional upgrading of local suppliers. The third group of variables may relate to the nature of the contract between the supplier and foreign firm, such as its length and the extent of division of labor in preparing drawings or blueprints. A longer contract with larger involvement of a supplier in the preparation of drawings would imply closer relational contracting, as suggested by Asanuma (1989) and Sturgeon et al. (2008). The fourth group refers to the composition of workers, including non-production workers engaged in pre- and post-production activities, as suggested by Gereffi (1999) and Sato and Fujita (2009).

As *Relational* is endogenous, we need instruments in the new estimation. According to the original ideas of the GVC study of Gereffi et al. (2005), the variables that refer to transaction costs of contracts, codification of production systems, and innate capacity of local suppliers can be those instruments. For example, the geographical distance between local and foreign firms is considered a proxy for the transaction costs of contractual relationships. The variables used for the measurement of "relationship-specific inputs," such as the share of intermediate inputs ordered with technical

specifications from MNEs (Defever and Toubal 2013) can be a proxy for the difficulty of the codification of the production system. We must further consider the careful selection of appropriate measures for the instrumental variables.

We believe that by integrating the analysis of productivity-focused FDI studies with the analysis of profit sharing by GVC studies, our understanding of the role of FDI in improving the efficiency of local firms will be deepened further.

## **Conclusions**

Given the rapid increase in the volume of FDI flows over the past several decades coupled with its potential role in transferring advanced technology and management practices from developed to developing countries, increasing scholarly attention has been paid to the productivity impacts of FDI on local firms in developing countries. This study reviewed the literature on the productivity impacts of GVCs and FDI, both of which are interested in the transfer of useful knowledge for the development of local firms in developing nations. Nonetheless, cross-references between GVC and FDI studies on the productivity impacts on local firms are severely lacking.

We first found that the literature on GVCs provides useful insights into the relationships between foreign and local firms, which depends on transaction costs, codifiability of production methods, and capability of local firms as well as the ways in which functions, products, and production processes are upgraded. Although many case studies support this argument, this strand of the literature remains largely conceptual and descriptive without rigorous quantitative analysis. Second, we found that FDI studies have made several significant findings, particularly the importance of the backward linkages between foreign firms in downstream industries and domestic firms in upstream industries rather than the horizontal linkages between firms in the same industry. Such a vertical relationship is the central issue addressed by GVC studies.

We also revealed that the specification of the estimation functions in FDI research suffers from several restrictive assumptions; for example, a common assumption is the existence of identical productivity effects of the presence of FDI across different industries. Furthermore, most FDI studies have failed to explore how useful knowledge is transferred from foreign to local enterprises in practice and, consequently, how the management behavior of local enterprises changes, although some studies have paid attention to the roles of the absorptive capacity of local enterprises and labor turnover from foreign to local enterprises in the knowledge transfer process.

To overcome the limitations of existing studies, this study has made several recommendations. First, it has suggested a possible way to avoid the limitations of the

estimation methods of the impact of FDI by extending the model of productivity improvement, originally developed by Griffith et al. (2004), to examine the effect of the technology gap between the frontier firm and other firms. Second, given that both GVC and FDI research are interested in knowledge transfer, this study has suggested several ways to enrich the latter by incorporating the insights of GVC research. In particular, we proposed incorporating the idea of the evolution of the contractual relationship from captive to relational suppliers into the estimation framework of FDI research.

Finally, although policymakers in developing countries are interested in the impact of FDI on industrial development, analysis of industrial development is outside the scope of both GVC and FDI research for two reasons. First, these two strands of studies are commonly concerned with productivity growth or the upgrading of functions, products, and processes in relatively short periods. Thus, neither strand analyzes the long-term dynamic process of industrial development. Second, analysis of the roles of entrepreneurs and “innovation” based on learning from FDI is lacking, even though the causes and consequences of entrepreneurial innovation are central to industrial development. For such an analysis, we must explicitly analyze what types of innovations are crucial for industrial development and the role played by entrepreneurial traits such as work experience in MNEs, the experience of receiving technology and management training, and schooling levels, based on the availability of detailed long-term data. Without such analysis, we will not be able to draw useful lessons for policymakers in developing countries, who are interested in promoting industrial development by attracting FDI.

### **Appendix: Revised estimation function assessing FDI impact**

By modifying the specification of Griffith et al. (2004), we propose the following function for an integrated econometric approach to FDI studies:

(A1)

$$\begin{aligned} \Delta \ln(A_d)_{ijt} = & \gamma_0 + \gamma_{1j} \left(\frac{R}{Y}\right)_{ijt-1} + \gamma_{2j} \ln \frac{(A_F)_{jt-1}}{(A_d)_{ijt-1}} + \gamma_{3j} \left(\frac{R}{Y}\right)_{ijt-1} * \ln \frac{(A_F)_{jt-1}}{(A_d)_{ijt-1}} \\ & + \gamma_4 \text{Backward}_{jt-1} + \gamma_5 \text{Forward}_{jt-1} + \mathbf{X}'_{ijt-1} \boldsymbol{\gamma}_5 + \mathbf{Z}'_{jt-1} \boldsymbol{\gamma}_6 + \alpha_i + \alpha_j + \alpha_t + \varepsilon_{ijt} \end{aligned}$$

where  $R$  is firm  $i$ 's expenditure on R&D;<sup>24</sup>  $A$  is TFP;  $\Delta \ln A$  is the growth rate of TFP;  $A_F$  and  $A_d$  are the TFP of foreign firms and domestic firms, respectively; and the other variables are the same as in equation (1). Note that the coefficients  $\gamma_{1j}$  to  $\gamma_{3j}$

can differ by industry.

In this specification, knowledge spillovers are assumed to affect productivity *changes* rather than productivity levels. We expect the term of the productivity gap between firm  $i$  and foreign firms within the same industry  $j$  to capture the spillover effects due to the demonstration effect (i.e.,  $\gamma_{2j}$ ), while the term interacted with the ratio of the firm's R&D expenditure to value-added captures the spillover effects from the imitation effect (i.e.,  $\gamma_{3j}$ ). In this way, we separate the imitation effects from the demonstration effects in this specification. We expect that  $\gamma_{2j}$  and  $\gamma_{3j}$  are positive. Moreover, according to Crespo and Fontoura (2007), the ratio of the firm's R&D expenditure can indicate the firm's absorptive capacity. The use of the TFP gap between each firm and foreign firms within the same industry allows each industry to have different demonstration and imitation effects.

The remaining drawback of this equation is the assumption of identical backward and forward linkage effects across industries and identical input-sourcing behaviors of foreign firms regardless of their nationality. This issue can be resolved only if we have access to firm-specific information representing the extent of the interaction between local and foreign firms.

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## Notes

<sup>1</sup> The value of FDI inflows to developing countries surpassed those to developed countries in 2012, for the first time (UNCTAD 2013).

<sup>2</sup> For representative surveys of the empirical literature, see Saggi (2002), Görg and Greenaway (2004), Crespo and Fontoura (2007), Smeets (2008), and Javorcik (2014).

<sup>3</sup> Note that the GVC studies we are interested in must be distinguished from those which attempt to explore a comprehensive and detailed picture of the dynamic network structure of the global economy using multi-country input-output tables, such as Dietzenbacher et al. (2005) and Johnson and Noguera (2012). Regarding a comprehensive overview of these GVC studies, see Dollar (2017) and Inomata (2017).

<sup>4</sup> The representative empirical studies on MNEs' organizational choice between FDI and foreign outsourcing are Yeaple (2006) for the US, Tomiura (2007) for Japan, Fernandes and Tang (2012) for China, Bernard et al. (2010) for the US, Corcos et al. (2013) for France, Defever and Toubal (2013) for France, and Nunn and Trefler (2013) for the US.

<sup>5</sup> See also Figure 3 of UNIDO (2004, 10).

<sup>6</sup> However, Sato (2011) finds that even in captive value chains a few local suppliers acquired the capabilities in non-production activities such as product design, indicating the importance of their learning strategies in capability building.

<sup>7</sup> In contrast, in the case of prouder-driven chains, which are observed in capital- and technology-intensive industries such as automobiles, lead firms are considered to engage in production activities, creating multilayered production systems.

<sup>8</sup> However, the demonstration effect is less likely to occur, since the products manufactured by foreign firms and local firms are different, even though local firms could copy improved management practices.

<sup>9</sup> An alternative measurement of the presence of FDI is the absolute value of employment (e.g., the number of workers employed by foreign firms), as suggested by Castellani and Zanfei (2003). If we assume that the demonstration effect is the main channel, the use of the absolute value is plausible because we can treat the existence of FDI like that of public goods.

<sup>10</sup> For simplicity, we show the fixed effects by  $\alpha$  in equation (A3) too.

<sup>11</sup> Note that since only intermediate products that foreign firms supply in the domestic market are relevant for forward linkages shown in equation (3), exports are often excluded from output in industry  $m$  for the measure of the foreign firms' share in industry  $m$  (Javorcik 2004; Barrios et al. 2011; Fatima 2016; and Lu et al. (2017) .

<sup>12</sup> Note that Blalock and Gertler (2008) use translog production function. Although Kokko (1994) and Jordaan (2008) also estimate equation (1), they use firm-level cross-sectional data.

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<sup>13</sup> Conceptually, this amounts to subtracting contributions of labor and capital from value-added in equation (1). In order to address the potential endogeneity of factor inputs, these studies use the techniques of Olley and Pakes (1996), Levinsohn and Petrin (2003) or Akerberg et al. (2015) for estimating TFP in the first stage.

<sup>14</sup> Moreover, according to equation (1), FDI does not contribute toward the domestic firm's productivity growth, if FDI share is constant, even though FDI presence in the absolute values increases due to new foreign firms, as Todo and Miyamoto (2006) point out.

<sup>15</sup> Note that Javorcik and Spatareanu (2011), analyzing firm-level panel data in Romania from 1998 to 2003, find that the strength of the backward linkage effect depends on the FDI nationality. To resolve this issue, Barrios et al. (2011) use the home country's input table rather than that of the host country, according to the foreign firms' nationality, for measuring the proportion of the industry output in question supplied to downstream industries. However, this use is also subject to another restrictive assumption that foreign affiliates in the host country have the same input-sourcing behavior as they are located in their home countries. With regard to the other two restrictive assumptions about the measurement of backward linkages, see Barrios et al. (2011, 863).

<sup>16</sup> Their specification originally assumes that the firm's growth of the R&D stock and other controls determine the productivity growth in a given firm. If the depreciation rate of the R&D stock is small, the growth of the R&D stock multiplied by the elasticity of output with respect to the R&D stock is reduced to the share of R&D expenditure in the value of output multiplied by the rate of return to R&D. For details, see equations (2) and (3) of Griffith et al. (2004, 884).

<sup>17</sup> See Aw et al. (2001) for an extension of the superlative-index-number approach to the case of combined cross-sectional and time-series data. Arnold and Javorcik (2009) use this approach to estimate TFP.

<sup>18</sup> However, a few studies analyzed vertical spillovers before Javorcik (2004). For example, Belderbos et al. (2001) analyze the determinants of the local content ratios of 272 Japanese electronics manufacturing affiliates in 24 countries in 1992.

<sup>19</sup> However, Liu (2008) finds negative inter-industry effects in the short term, as in the case of intra-industry effects. In contrast, Chung et al. (2003) find that local suppliers providing components to Japanese assemblers (tie-in firms) do not receive significant vertical spillover effects, although such suppliers have a higher survival rate than other suppliers (non-tie-in firms) in the automobile industry in the US from 1979 to 1991.

<sup>20</sup> See also equation (3) of Smeets (2008, 115).

<sup>21</sup> See equation (4) of Smeets (2008, 115). In this equation, the dependent variable is individual workers' wages instead of firm-level productivity. However, the independent variables are the same, except for additional inclusion of individual workers' characteristics such as age, educational level, and occupational category.

<sup>22</sup> Lipsey and Sjöholm (2004) find that foreign-owned firms pay higher wages for a given educational level

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than domestically owned ones, possibly due to the acquisition of improved knowledge by workers in foreign firms.

<sup>23</sup> See equation (5) of Smeets (2008, 118).

<sup>24</sup> If firm-level data on R&D expenditure are not available, proxy variables such as the share of skilled workers in total employment can be used.

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